

इंटरनेट

मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

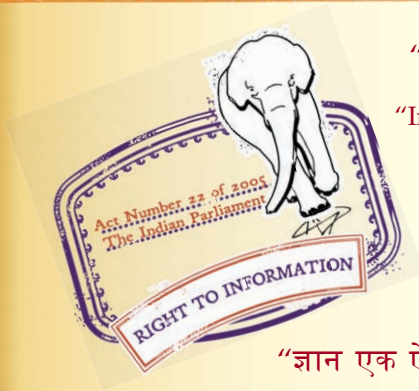
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 13573 (1992): Joints and Terminations of Polymeric Cables for Working Voltages from 66kV Up To and Including 33 kV - Performance Requirements and Type Test [ETD 9: Power Cables]



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE



भारतीय मानक

6.6 कि. वो. से 33 कि. वो. तक कार्यकारी वोल्टता के
पालीमर पावर केबिलों के जोड़ और अन्तक — कार्यकारिता
अपेक्षाएँ और टाइप परीक्षण

Indian Standard

**JOINTS AND TERMINATIONS OF POLYMERIC
CABLES FOR WORKING VOLTAGES FROM
6.6 kV UP TO AND INCLUDING 33 kV —
PERFORMANCE REQUIREMENTS AND
TYPE TESTS**

UDC 621.315.687.620.16

© BIS 1992

**BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002**

October 1992

Price Group 4

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Power Cables Sectional Committee had been approved by the Electrotechnical Division Council.

Many methods are in vogue for making joints and terminations of cables using different materials and techniques. This standard does not refer to materials to be used or actual method of jointing/termination. However, it is expected that materials to be used would be inert and capable of resisting degradation during the service life of the cable system.

The joints and terminations of cables are normally made at site. For practical reasons, this standard is confined to type tests only. For tests at site, reference may be made to IS 1255 : 1983 'Code of practice for installation and maintenance of power cables up to and including 33 kV rating (*third revision*)'.

The cable joints/terminations should normally have same electrical and thermal characteristics as the cable for which these are intended. As such this standard is to be used in conjunction with the relevant specification. At present these specifications are:

- a) IS 1554 (Part 2) : 1988 PVC insulated (heavy duty) electric cables: Part 2 For working voltages from 3.3 kV up to and including 11 kV (*second revision*),
- b) IS 7098 (Part 2) : 1985 Crosslinked polyethylene insulated PVC sheathed cables: Part 2 For working voltages from 3.3 kV up to and including 33 kV (*first revision*), and
- c) IS 9968 (Part 2) : 1985 Elastomer insulated cables: Part 2 For working voltages from 3.3 kV up to and including 11 kV [*superseding* IS 434 (Parts 1 and 2)].

Performance requirements of this standard are applicable to screened cables only. Should however any deviation exist between individual cable specification and this standard, the provisions, of the later shall apply.

While preparing this standard assistance has been derived from Parts 1 and 5 of the VDE 0278 'Power cable accessories with rated voltage up to 30 kV', issued by the German Electrotechnical Commission in DIN & VDE.

This standard does not cover joints and terminations for use with paper insulated cables.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

**AMENDMENT NO. 1 MARCH 1996
TO
IS 13573 : 1992 JOINTS AND TERMINATIONS OF
POLYMERIC CABLES FOR WORKING VOLTAGES
FROM 6.6 kV UP TO AND INCLUDING 33 kV —
PERFORMANCE REQUIREMENTS AND TYPE
TESTS**

(Foreword, para 6) — Insert the following at the end:

“and IEC-502 (1989) ‘Extruded solid dielectric insulated power cables for rated voltages from 1 kV up to 30 kV’, issued by the International Electrotechnical Commission (IEC).”

(Page 1, clause 4.3) — Substitute the following for the existing clause:

‘4.3 Number of joints and terminations shall be as follows:

- a) For testing joints/terminations for three core cables any one of the following arrangements shall be submitted for testing:
 - i) Two cable loops having two cable end terminations (indoor/outdoor) each as given in Fig. 1(a) or Fig. 1(b),
 - ii) Two cable loops each having one joint and two cable end terminations (indoor/outdoor) as given in Fig. 1(c), and
 - iii) One loop having two joints and two cable end terminations (applicable only for testing joints) as given in Fig. 1(d).
- b) For testing joints/terminations for single-core cables, any one of the following arrangements shall be submitted for testing:
 - i) Two cable loops having two cable end terminations (indoor/outdoor) each as given in Fig. 1(e) or Fig. 1(f),
 - ii) Two cable loops each having two joints and two cable end terminations (indoor/outdoor) as given in Fig. 1(g), and
 - iii) One loop having four joints and two cable end terminations (applicable only for testing joints) as given in Fig. 1(h).

The arrangements for the tests are shown in Fig. 1.

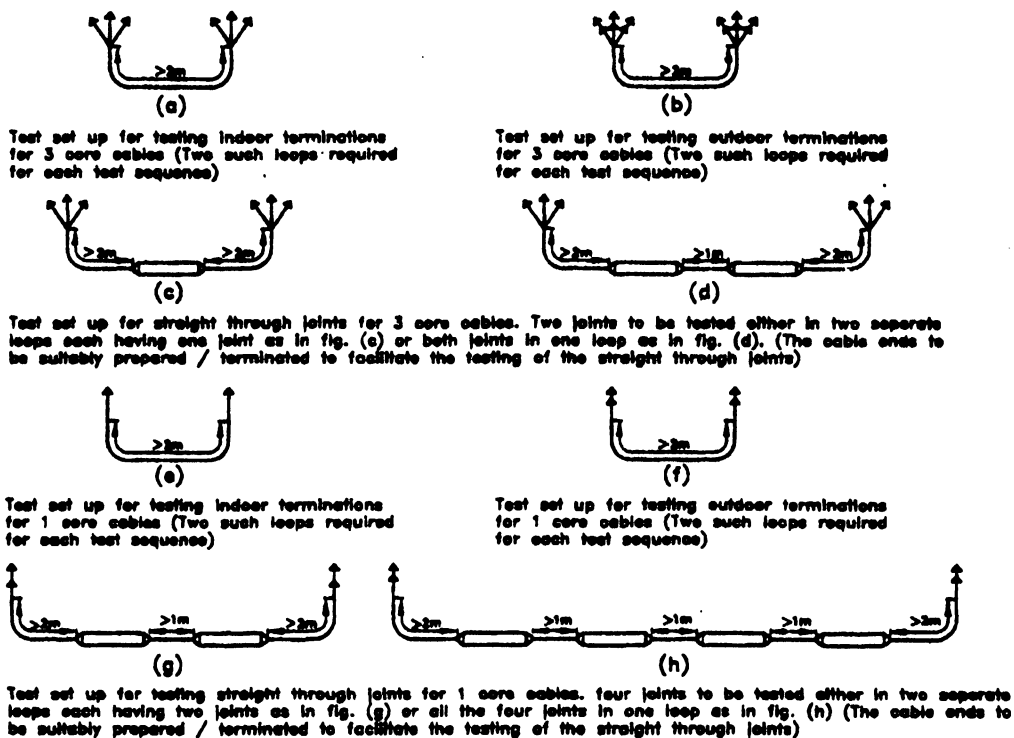


FIG. 1 TEST ARRANGEMENTS FOR JOINTS AND TERMINATIONS

Amend No. 1 to IS 13573 : 1992

(Page 1, clause 4.4.1) — Substitute the following for the existing clause:

‘4.4.1 The cable of nominal cross section of 240 mm² and above shall be used for dynamic short circuit test. The sequence of test shall be in accordance with Table 1.

4.4.2 This test in 4.4.1 shall be conducted under test series 2. The magnitude of the short circuit current, the diameter and the size of the cable to be used shall be decided between the manufacturer and the user. After the dynamic short circuit test, the impulse test and d.c. high voltage test shall be carried out.’

(Pages 1 and 2, clause 6.1, line 2) — Substitute ‘Fig. 2’ for ‘Fig. 1’.

(Pages 1 and 2, clause 6.1, line 5) — Substitute ‘2 m’ for ‘2 mm’.

(Pages 1 and 2, clause 6.1, last sentence) — Insert the following before the last sentence:

‘The drops shall be distributed over the length of the joint.’

(Pages 1 and 2, clause 6.1, New Note) — Add the following Note at the end of the clause:

‘NOTE — Impact test is applicable for joints on armoured cables only and is not applicable for joints on unarmoured cables.’

(Page 2, Fig. 1) — Substitute ‘Fig. 2’ for ‘Fig. 1’.

(Page 2, clause 6.2, para 2, first sentence) — Insert the word ‘of’ between the words ‘conductor’ and ‘the’.

(Page 2, clause 6.2, para 4) — Substitute the following for the existing:

‘The test voltage is raised to the specified value as given in Table 1 and is maintained for one minute.’

(Page 2, clause 6.3, last line) — Substitute ‘SI No. 5’ for ‘SI No. 4’.

(Page 3, Table 1):

Column 1, new entry — Insert ‘Test series 1’ above ‘SI No. 1’.

SI No. 6a, 6b, and 10 and the corresponding entries — Delete and renumber the subsequent serial numbers.

Column 2, SI No. 3 — Delete the words ‘(for outdoor terminations)’.

Column 3, SI No. 1 — Add reference to clause 6.12.

Amend No. 1 to IS 13573 : 1992

(Page 4, Table 1):

Column 2, Sl No. 13b — Substitute '(only for outdoor termination)' for '(only for indoor terminations)'.

Column 2, Sl No. 13c — Substitute 'Water tightness test (for joints only)' for the existing text.

Column 1, new entry — Insert between Sl No. 16 and Sl No. 17 'Test series 2'.

Sl No. 16, columns 5 to 8 — Substitute the values '28, 48, 96 and 144' for '60, 75, 125 and 170' respectively.

Column 9, Sl No. 17 — Substitute 'c) Decolouration and deposits not considered for evaluations' for the existing text.

Sl No. 19, columns 5 to 8 — Substitute the values '63, 40, 40, 40' for '63, 43, 43, 43' respectively.

Notes — Delete 'NOTE 2'.

(Page 5, clause 6.5.2, line 1) — Insert the words 'Joints and' after 'indoor/outdoor'.

(Page 5, clause 6.5.3, para 2, line 3) — Substitute the word 'During' for 'Duing'.

(Page 5, clause 6.5.3, para 2, line 5) — Substitute '700 $\pm$ 100 micro-mhos/cm' for '1700 $\pm$ 100/cm'.

(Page 5, clause 6.5.3, para 2, last line) — Insert the word 'out' after the word 'carried'.

(Page 5, Table 2, columns 5 to 10) — Add the unit 'in kA' after 'Thermally Effective Short Circuit Current' at the top.

(Page 6, clause 6.9, para 1, last sentence) — Substitute 'Fig. 3' for 'Fig. 2'.

(Page 6, Fig. 2) — Substitute 'Fig. 3' for 'Fig. 2'.

(Page 7, clause 6.11) — Add the new clause after 6.11:

'6.12 The cable length along with joints and terminations shall be checked for conductor resistance in accordance with IS 10810 (Part 5).'

Amend No. 1 to IS 13573 : 1992

(Page 7, Annex A) — Insert the following reference after IS 1885 (Part 32):
'IS 10810 (Part 5) : 1984 Methods of test for cables: Part 5 Conductor
resistance test'.

(ETD 9)

AMENDMENT NO. 2 AUGUST 1998

TO

**IS 13573 : 1992 JOINTS AND TERMINATIONS OF POLYMERIC
CABLES FOR WORKING VOLTAGES FROM 6.6 kV UPTO AND
INCLUDING 33 kV — PERFORMANCE REQUIREMENTS
AND TYPE TESTS**

(*Page 1, clause 4.4*) — Substitute the following for the existing clause:

4.4 The test specimen shall be made out of cables of any of the following nominal cross sections:
120 mm² or 150 mm² or 185 mm² or 240 mm²

[*Page 1, clause 4.4.2 (see also Amendment No. 1)*] — Delete.

(*Page 1, clause 5.2*) — Substitute the following for the existing clause:

5.2 If a joint/termination does not pass a test under Table 1, SI No. 1 to 14, the sequence of tests from SI No. 1 to 14 shall be repeated on a freshly prepared test specimen.

5.2.1 Tests under SI No. 15 and 16 in accordance with Table 1 may be performed on an additional test specimen which have not been previously subjected to other tests.

5.2.2 If the specimen does not pass a test under SI No. 15 (Humidity Test) or SI No. 16 (Salt Fog Test) of Table 1, only this test need be repeated on a freshly prepared test specimen.

5.2.3 If a joint/termination does not pass a test under Series 2, SI No. 1 to 3 given in Table 1 only this sequence from SI No. 1 to 3 shall be repeated on a freshly prepared test specimen.'

(*Pages 1 and 2, clause 6.1, line 5*) — Insert the words 'on each joint' between the words 'times' and 'from'.

[Pages 3 and 4, Table 1 (see also Amendment No. 1)] — Substitute the following for the existing table:

Table 1 Type Tests
(Clauses 5.1, 5.2, 5.2.1, 5.2.2, 5.2.3, 6.3, 6.8, 6.9 and 6.10)

Sl No.	Test Sequence	Reference	Parameters for Evaluation	Test Value in kV				Criteria of Evaluation
				Rated Voltage U_J/U in kV				
(1)	(2)	(3)	(4)	3.8/6.6	6.35/11	12.7/22	19/33	(9)
Series 1								
1.	Conductor resistance	IS 10810 (Part 5) and Clause 6.12	—	—	—	—	—	Resistance value shall be computed and corrected at 20°C and recorded
2.	Impact (only for joints)	Clause 6.1	—	—	—	—	—	There shall be no visible damage
3.	ac voltage withstand test	Clause 6.2	Duration 1 minute	27	35	55	75	There shall be no breakdown
4.	ac voltage withstand test (under wet conditions) (for outdoor termination only)	—	Duration 1 minute	20	28	50	70	There shall be no breakdown
5.	Partial discharge	Clause 6.3	Test voltage	←	2 U_p		→	PD magnitude shall not exceed 20 pC for accessories for elastomeric and XLPE and 40 pC for PVC cables
6.	Impulse withstand	Clause 6.4	—	60	75	125	170	There shall be no breakdown or flashover
7.	ac voltage life test with cyclic current loading	Clause 6.5.1	Number of cycles — 3	←	2.5 U_p		→	There shall be no breakdown or flashover
8.	Partial discharge	Clause 6.3	Test voltage	←	2 U_p		→	PD magnitude shall not exceed 20 pC for accessories for elastomeric and XLPE and 40 pC for PVC cables
9.	ac voltage life test with cyclic current loading	Clause 6.5.1	Number of cycles — 60	←	2.50 U_p		→	There shall be no breakdown or flashover

Table 1 (Continued)

Sl No.	Test Sequence	Reference	Parameters for Evaluation	Test Value in kV				Criteria of Evaluation
				Rated Voltage U_0 in kV				
(1)	(2)	(3)	(4)	3.8/6.6 (5)	6.35/11 (6)	12.7/22 (7)	19/33 (8)	(9)
10.	Thermal short circuit	Clause 6.6	Current according to type of cable as given in Table 2	—	—	—	—	There shall be no visible damage Temperature of the conductor shall not exceed the maximum short circuit temperature specified in Table 2
11a.	ac voltage life test with cyclic current loading (only for indoor terminations)	Clause 6.5.2	Number of cycles — 63	←	—	$2.5 U_0$	—	There shall be no breakdown or flashover
11b. i)	ac voltage life test with cyclic current loading (only for outdoor terminations)	Clause 6.5.2	Number of cycles — 54	←	—	$2.5 U_0$	—	There shall be no breakdown or flashover
	ii) Leak tightness (for outdoor terminations only)	Clause 6.5.3	Number of cycles — 9	←	—	No voltage	—	
11c.	Water tightness (for joints only)	Clause 6.7	Number of cycles — 60	←	—	$2.5 U_0$	—	There shall be no breakdown
12.	Conductor resistance	IS 10810 (Part 5)	—	—	—	—	—	Resistance shall not vary from the value measured at SI No. 1 by more than 10 percent
13.	Impulse withstand	Clause 6.4	—	60	75	125	170	There shall be no breakdown or flashover
14.	dc voltage withstand	Clause 6.8	Duration 30 minutes	28	48	96	144	There shall be no breakdown or flashover
15.	Influence of humidity (for indoor terminations only)	Clause 6.9	Duration 100 hours	4	7	14	21	a) There shall not be any excess current release. However, in

Table 1 (Concluded)

SI No.	Test Sequence	Reference	Parameters for Evaluation	Test Value in kV Rated Voltage U _{JU} in kV				Criteria of Evaluation
(1)	(2)	(3)	(4)	3.8/6.6	6.35/11	12.7/22	19/33	(9)
				(5)	(6)	(7)	(8)	
16.	Salt fog (only for outdoor terminations)	Clause 6.10	Duration 1 000 h	Not applicable	7	14	21	c) Decolouration and deposits are not considered for evaluation. Not more than three excess current trippings should occur. No screen pin hole discharge should occur. No traces of erosion which extends up to cable insulation should be observed.
Series 2								
1.	Dynamic short circuit	Clause 6.11	Mechanical short circuit	$2.55 \times I_{sc}$	$2.55 \times I_{sc}$	$2.55 \times I_{sc}$	$2.55 \times I_{sc}$	No mechanical damage should be observed
2.	Impulse withstand	Clause 6.4	—	60	75	125	170	There shall be no breakdown or flashover
3.	dc voltage withstand	Clause 6.8	Duration 30 minutes	28	48	96	144	There shall be no breakdown or flashover
NOTES								
1 Test at SI No. 15 and 16 of Series 1 may be conducted on separate test loops, however, number of samples and test set up is in accordance with 4.3.								
2 Tests at SI No. 2 and 3 of Series 2 are applicable only for accessories for which dynamic short circuit test is required.								
3 I_{sc} is the rated short circuit value (kA r.m.s.) of the cable (240 mm ² or above) under test.								
4 For example, I_{sc} for 240 mm ² aluminium conductor, XLPE insulated cable is 22.68 kA.								

NOTES

- 1 Test at SI No. 15 and 16 of Series 1 may be conducted on separate test loops, however, number of samples and test set up is in accordance with 4.3.
- 2 Tests at SI No. 2 and 3 of Series 2 are applicable only for accessories for which dynamic short circuit test is required.
- 3 I_{sc} is the rated short circuit value (kA r.m.s.) of the cable (240 mm² or above) under test.
- 4 For example, I_{sc} for 240 mm² aluminium conductor, XLPE insulated cable is 22.68 kA.

[Page 5, clause 6.5.2, line 1 (see also Amendment No. 1)] — Insert the words ‘and joints’ after the word ‘terminations’.

(Page 5, Table 2) — Substitute the following for the existing table:

Table 2 Thermally Effective Short Circuit Current for Heating the Conductor to Short Circuit Temperature in One Second
(Clause 6.6, and Table 1)

Sl No.	Type of Cable	Normal Operating Temperature °C (Max)	Short Circuit Temperature °C (Max)	Thermally Effective Short Circuit Current (kA).							
				Copper Conductor, Size mm ²				Aluminium Conductor, Size mm ²			
				120	150	185	240	120	150	185	240
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
i)	XLPE insulated	90	250	17.16	21.46	26.47	34.34	11.33	14.16	17.48	22.68
ii)	Elastomer insulated										
	a) Butyl rubber	85	220	16.10	20.12	24.82	34.20	11.31	13.29	16.39	21.26
	b) Ethylene propylene rubber	90	250	17.17	21.46	26.47	34.34	11.33	14.17	17.47	22.68
iii)	PVC insulated										
	a) 3.3 and 6.6 kV (earthed and unearthed)	70	150	13.09	16.37	20.19	26.19	8.60	10.82	13.35	17.32
	b) 11 kV (earthed)	60	140	13.29	16.61	20.49	26.58	7.73	10.99	13.55	17.58

(Page 6, clause 6.8, line 3) — Substitute ‘not’ for ‘note’.

Indian Standard

JOINTS AND TERMINATIONS OF POLYMERIC CABLES FOR WORKING VOLTAGES FROM 6.6 kV UP TO AND INCLUDING 33 kV — PERFORMANCE REQUIREMENTS AND TYPE TESTS

1 SCOPE

1.1 This standard covers the performance requirements and type tests for joints and terminations of power cables for voltage grades from 6.6 kV up to and including 33 kV.

1.2 This standard does not apply to transition joints for dissimilar cables.

2 REFERENCES

The Indian Standards given in Annex A are necessary adjuncts to this standard.

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 1885 (Part 32) : 1971 and the following shall apply.

3.2 Type Test

Tests carried out to prove conformity with the standard. These are intended to prove the general qualities and design of a particular type of joint and/or termination.

4 TEST SPECIMENS

4.1 The test specimens shall be made out of cable lengths which meet the following requirements:

Partial discharge magnitude at $2 U_0$ shall not exceed the limit prescribed for:

XLPE and Elastomeric Cables	20 pC
PVC Cables	40 pC

4.2 The test specimen shall be made in the testing laboratory by using the materials prescribed and in accordance with the instructions of joint/termination kit (system) supplied by the manufacturer. The accessories kit shall be of the same nominal voltage as the cable sample.

4.3 Number of joints and terminations shall be as follows:

- a) Joints — For single core cables, at least four joints shall be tested. In case of three core cables, at least two joints shall be tested.
- b) Indoor and outdoor terminations — For single core cables, two test specimens with four terminations shall be tested. In case of three core cables, six terminations shall be tested.

4.4 The test specimens shall be made generally out of cables of nominal cross section of 150 mm². In case 150 mm² cable is not available, cables with 120 mm² or 185 mm² may be used.

4.4.1 For dynamic short circuit test, cable of nominal cross section of 240 mm² and above shall be used.

4.5 The length of the test specimen between testing terminals shall not be less than 5m. The length between the joints and terminations shall not be less than 2m and the distance between joints shall not be less than 1m.

5 TEST AND EVALUATION

5.1 Type tests and their sequence with test conditions and evaluation criteria shall be as specified in Table 1.

5.2 If a joint/termination does not pass the test, the entire type tests shall be repeated on a freshly prepared test specimen.

5.3 If during testing a cable damage occurs, it may be repaired. If repair is not possible, then the tests should be repeated on a fresh specimen.

6 TEST PROCEDURE

6.1 Impact Test

The joint shall be placed on a hard base of concrete slab or floor as shown in Fig 1. A

wedge shaped mass of 4 kg having a 90° angle with a 2 mm radius impacting edge shall be dropped freely 6 times from a height of 2 m on the specimen in such a manner that impacting edge is horizontal and at right angles to the axis of the joint. There shall be no visible damage to the joint.

6.2 ac Voltage Withstand Test

This test shall be carried out in accordance with IS 10810 (Part 45) : 1984.

The high voltage is connected to the conductor the core under test. The cores not under test, screen and armour are connected to the earth terminal, depending on the mode of connection.

The voltage shall be raised sufficiently slowly to permit accurate reading of the measuring instrument but not so slowly as to cause unnecessary prolongation of the stress near the test voltage.

The test voltage is raised to the specified value and is maintained for one minute.

After the specified time, the voltage is rapidly decreased but not interrupted suddenly to avoid the possibility of switching transients which may affect the subsequent test results.

6.3 Partial Discharge Test

This test is applicable to joints and terminations of screened cables with thermoplastic and elastomeric (including XLPE) insulation only. This test shall be carried out in accordance with IS 10810 (Part 46) : 1984. The test voltage shall be as per Sl No. 4 of Table 1.

NOTE — The sample is not subjected to bending operations before this test.

6.4 Impulse Withstand Test

This test shall be carried in accordance with IS 10810 (Part 47) : 1984, but the sample at room temperature. The test specimen shall withstand without breakdown, 10 positive and 10 negative impulses with 1.2/50 micro-seconds wave.

6.5 ac Voltage Life with Cyclic Current Loading

6.5.1 The test specimen (joint/terminations) shall undergo specified number of cycles. Each cycle consists of a five hour heating period and three hour cooling period without current. The heating current depends upon the size of the conductor and cable type. The current should be adjusted so as to raise the conductor temperature to 10°C higher than its specified normal operating temperature. The specified ac voltage should be applied continuously during heating and cooling period.

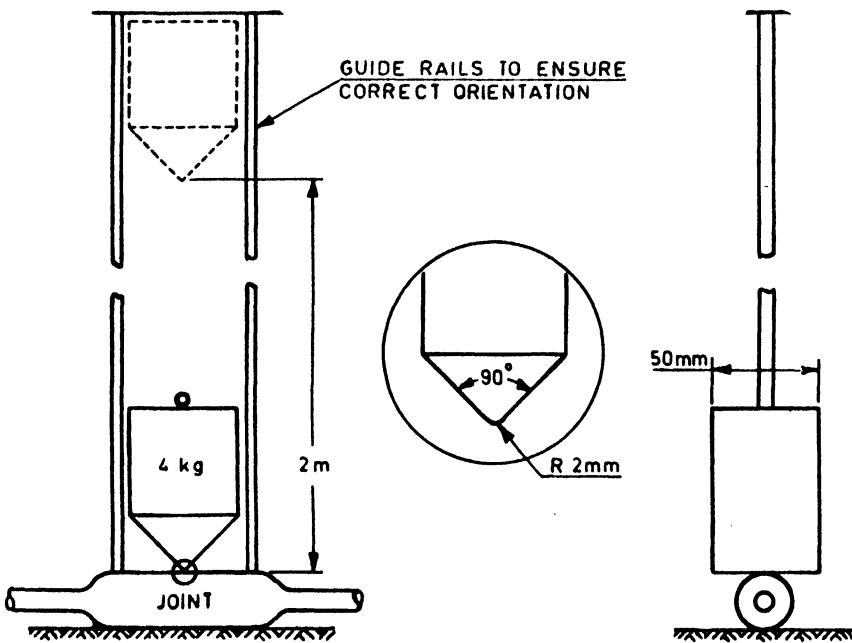


FIG. 1 IMPACT TEST APPARATUS

Table 1 Type Tests
(Clauses 5.1, 6.3, 6.8 and 6.9)

Sl No.	Test Sequence	Reference	Parameters for Evaluation	Test Value in kV Rated Voltage U_0/U in kV				Criteria of Evaluation
				3.8/6.6	6.35/ 11	12.7/ 22	19/ 33	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1.	Conductor resistance	IS 10810 (Part 5)	—	—	—	—	—	Resistance value shall be computed and corrected at 20° C and recorded
2.	Impact (only for joints)	Clause 6.1	—	—	—	—	—	There shall be no visible damage
3.	ac voltage withstand test (for outdoor termination)	Clause 6.2	Duration 1 m	27	35	55	75	There shall be no breakdown
4.	ac voltage withstand test (under wet conditions) (for outdoor termination)	Clause 6.2	Duration 1 m	20	28	50	70	There shall be no breakdown
5.	Partial discharge	—	Test voltage	$\longleftrightarrow 2U_0 \longleftrightarrow$				PD magnitude shall not exceed 20 pC for accessories for elastomeric and XLPE and 40 pC for PVC cables
6a.	Dielectric power factor as a function of voltage	IS 10810 (Part 48)	—	—	—	—	—	As per relevant cable specification
6b.	Dielectric power factor as a function of temperature	IS 10810 (Part 48)	—	—	—	—	—	As per relevant cable specification
7.	Impulse withstand	Clause 6.8	—	60	75	125	170	There shall be no breakdown or flashover
8.	ac voltage life test with cyclic current loading	Clause 6.5.1	Number of Cycles-3	$\longleftrightarrow 2.5U_0 \longleftrightarrow$				There shall be no breakdown or flashover
9.	Partial discharge	—	Test voltage	$\longleftrightarrow 2U_0 \longleftrightarrow$				PD magnitude shall not exceed 20 pC for accessories for elastomeric and XLPE and 40 pC for PVC cables
10.	Dielectric power factor as a function of voltage	IS 10810 (Part 48)	—	—	—	—	—	As per relevant cable specification
11.	ac voltage life test with cyclic current loading	Clause 6.5.1	Number of cycles-60	$\longleftrightarrow 2.5U_0 \longleftrightarrow$				There shall be no breakdown or flashover
12.	Thermal short circuit	Clause 6.6	Current according to type of cable as given in Table 2	—	—	—	—	There shall be no visible damage. Temperature of the conductor shall not exceed the maximum short circuit temperature specified in Table 2
13a.	ac voltage life test with cyclic current loading (only for indoor terminations)	Clause 6.5.2	Number of cycles-63	$\longleftrightarrow 2.5U_0 \longleftrightarrow$				There shall be no breakdown or flashover

Table 1 — (concluded)

Sl No.	Test Sequence	Reference	Parameters for Evaluation	Test Value in kV Rated Voltage U_0/U in kV				Criteria of Evaluation
				3·8/6·6	6·35/ 11	12·7/ 22	19/ 33	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
13b.	i) ac voltage life test with cyclic current loading (only for indoor terminations) ii) Leak tightness	Clause 6.5.2	Number of cycles-54	$\leftarrow 2\cdot5U_0 \rightarrow$				There shall be no breakdown or flashover
		Clause 6.5.3	Number of Cycles-9	$\leftarrow \text{No voltage} \rightarrow$				
13c.	Water tightness only	Clause 6.7	Number of cycles-60	$\leftarrow 2\cdot5U_0 \rightarrow$				There shall be no breakdown
14.	Conductor resistance	IS 10810 (Part 5)	—	—	—	—	—	Resistance shall not be more than 10 per cent of the value measured at Sl No. 1
15.	Impulse withstand	Clause 6.8	—	60	75	125	170	There shall be no breakdown or flashover
16.	dc voltage withstand	Clause 6.8	Duration-30 minutes	60	75	125	170	There shall be no breakdown or flashover
17.	Influence of humidity	—	Duration-100 hours	4	7	14	21	a) There shall not be any excess current release. However in case of excess current release without traces of carbon containing surface track, reactivating three times is allowed. b) On end terminations, there shall not be any traces of surface leakage tracks visible to naked eye and traces of carbon which can be wiped off are permitted c) Decolouration and deposits are not permitted
18.	Salt fog (only for outdoor terminations)	—	Duration-1 000 hours	Not applicable	7	14	21	Not more than three excess current trippings should occur. No screen pin hole discharge should occur. No traces of erosion which extends up to cable insulation should be observed.
19.	Dynamic short circuit	—	Mechanical short circuit	63	43	43	43	No mechanical damage should be observed
20.	Impulse withstand	Clause 6.8	—	60	75	125	170	There shall be no break down or flashover
21.	dc voltage withstand	Clause 6.8	Duration-30 minutes	28	48	96	144	There shall be no breakdown or flashover

NOTES

- 1 Tests at Sl. No. 20 and 21 are applicable only for accessories for which dynamic short circuit test is required.
- 2 Tests at Sl. No. 6 (a) and 6 (b) are not applicable for 3·8/6·6 kV rating.

6.5.1.1 The conductors may be connected in series and heated in single phase.

6.5.1.2 The conductors are heated in three phases.

6.5.1.3 The conductors may be heated in three separate heating circuits. In case of cables with magnetic reinforcement, these should be switched to a polyphase ac system with symmetrical phases.

6.5.2 The indoor/outdoor terminations of the test specimen shall be subjected to ac voltage life test with cyclic current loading as per 6.5.1.

6.5.3 Leak Tightness Test

This test is applicable only to outdoor terminations.

The outdoor termination shall be placed in a water filled container, so that it is completely immersed in water. During the test, the conductivity of water shall be maintained as $1700 \pm 100/\text{cm}$. The test specimen shall undergo 9 cycles of heating and cooling as per 6.5.1 without application of voltage. The test shall be carried at room temperature.

6.6 Thermal Short Circuit Test

Before starting the short circuit test, the conductor of the test specimen shall be heated to normal operating temperature as specified in the relevant cable specification.

Thermally effective short circuit current, as per Table 2, shall then be passed through the conductor of the specimen for a duration of one second.

NOTE — The values of short circuit current have been calculated according to the formula given in Annex B.

The voltage applied to the test circuit shall not be higher than that required for achieving the short circuit current.

6.7 Test for Water Tightness

This test is applicable only for straight through joints. If the specimen consists of a joint with end terminations, the joint alone shall be immersed in water. The ac voltage life test with cyclic current loading as per 6.5.1 shall be carried out with joint immersed in water. The specified ac voltage shall be applied during heating and cooling period.

6.7.1 Test Arrangement

The joint shall be placed in a container filled with water in such a manner that the distance between the upper side of the cable, the neck of the joint and the water level is at least 250 mm. The joint may lie at bottom of the container. During the test, the water temperature shall not exceed 40°C.

Table 2 Thermally Effective Short Circuit Current for Heating the Conductor to Short Circuit Temperature in one Second

(Clause 6.6)

Sl No.	Type of Cable	Normal Operating Temperature °C (Max)	Short Circuit Temperature °C (Max)	Thermally Effective Short Circuit Current					
				Copper Conductor			Aluminium Conductor		
				120 mm ²	150 mm ²	185 mm ²	120 mm ²	150 mm ²	185 mm ²
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	XLPE insulated	90	250	17.16	21.46	26.47	11.33	14.16	17.48
2.	Elastomer insulated								
	a) Butyl rubber	85	220	16.10	20.12	24.82	11.31	13.29	16.39
	b) Ethylene propylene rubber	90	250	17.17	21.46	26.47	11.33	14.17	17.47
3.	PVC insulated								
	a) 3.3 and 6.6 kV (earthed and unearthed)	70	150	13.09	16.37	20.19	8.60	10.82	13.35
	b) 11 kV (earthed)	60	140	13.29	16.61	20.49	7.73	10.99	13.55

6.7.2 Cutting of the Sheath

In case of thermoplastic or elastomeric cables, at the cable inlets to the joint, the outer sheath and inner sheath wherever available, should be removed for a minimum length of 50 mm so that the metallic screen of the cable is exposed. This will be done at a distance of 50 mm from the neck of the joint.

6.8 dc Voltage Withstand Test

The conductor of the core under test shall be connected to the negative pole and the core note under test and earth lead are connected to the positive pole of the dc power supply. The voltage shall be raised sufficiently slowly to permit accurate readings of the measuring instruments but not so slowly as to cause unnecessary prolongation of the stress near the test voltage. The test voltage is raised to the specified value (see Table 1) and maintained for 30 minutes. After the specified time, the voltage is gradually reduced to zero.

6.9 Testing of Indoor Termination under Influence of Humidity

This test shall be carried out only on end terminations with aggravated surroundings.

The test chamber to be used for this test is restricted in size from 3 to 10 cubic meter. The humidity inside the chamber is created using a water sprayer. The test specimen shall be mounted as shown in Fig. 2.

Test specimen shall be subjected to an ac voltage (see Table 1, SI No. 17) for 100 hrs in the humidity chamber, where water with a conductivity of 700 to 800 us/cm shall be sprayed at a rate of 0.3 ± 0.1 litre/hour/cubic meter of the test chamber. An overload circuit breaker which operates for a circuit of 1 ± 0.1 A shall be connected in the earth lead of the specimen.

6.10 Salt Fog Test

This test is applicable only for outdoor terminations.

The testing chamber which is moisture tight and corrosion resistant, must be of 10 cubic meter volume with a height of 2.5 m. For producing the conductive fog, water sprayer with constant spraying capacity such as turbo-sprayers shall be used. The rate of water spray must be adjusted for 0.4 ± 0.1 litre/cubic meter/hour, so that the air in the chamber become saturated with moisture.

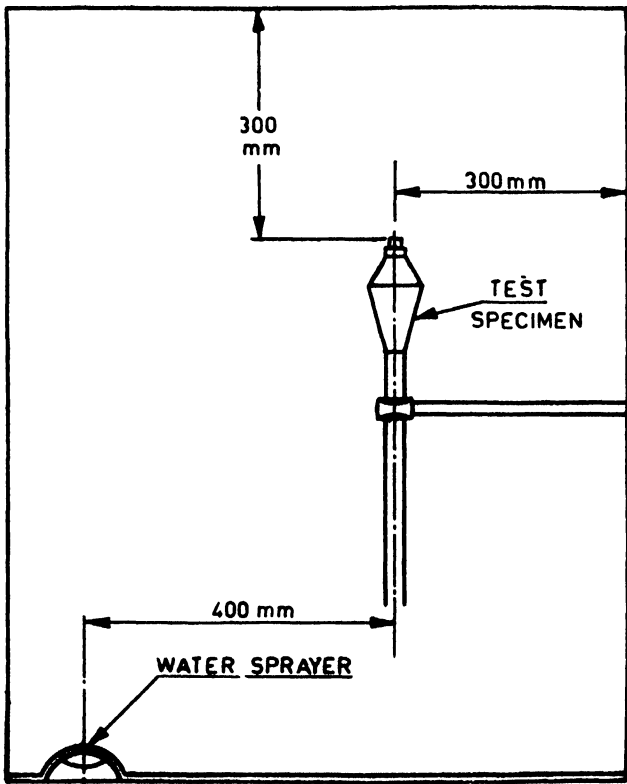


FIG. 2 WATER SPRAYER AND INDOOR TERMINATION POSITIONS INSIDE THE HUMIDITY CHAMBER

The outdoor termination shall be mounted inside the test chamber, with a minimum of 300 mm clearance from the wall of the chamber. The water sprayer should be placed in such a way that water does not fall on the termination directly. The salinity of the salt water to be sprayed must be 10 kg/m³. The salt water can be made by using distilled or desalinated water and commercial sodium chloride. The conduction must be checked before and after test and also during test at certain intervals using any commercially available conductivity testing meter.

The test voltage as specified in Table 1 shall be applied. The water sprayer is started after switching on the test voltage. Repeated interruptions of testing are permitted for checks, however they are not counted as testing durations. A single interruption should not exceed 15 minutes. An excess current tripping must be provided in the earth lead of test specimen for a trip current of 1 ± 0.1 A. It must be ensured that the testing equipment get switched-off in case of a current of 1 ± 0.1 A in the earth lead of the test specimen.

6.11 Dynamic Short Circuit Test

Before starting the test, the conductor of the test specimen shall be heated to its normal operating temperature by passing suitable current through the conductor. The peak current of 2.55 times the thermal short circuit current shall be established with oscillograph. The duration of the current should be selected in such a way that at least half cycle is achieved during the test. The voltage applied to the test circuit should not be higher than required to achieve the short circuit current.

Accessories for single core cables shall be tested by connecting the test specimen across two phases of the output of the test arrangement and those of three core cables across the three phases of the test arrangement.

The dynamic short circuit test shall be applicable for cable accessories of voltage range 11, 22 and 33 kV, if the mechanical short circuit strength is more than 40 kA; and for 6.6 kV voltage range, if the mechanical short circuit strength is 63 kA or more.

This test is not applicable for single core cable joint.

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
1885 (Part 32) : 1971	Electrotechnical Vocabulary : Part 32 Cables, conductors and accessories for electric supply	10810 (Part 46) : 1984	Methods of test for cables : Part 46 Partial discharge test
		10810 (Part 47) : 1984	Methods of test for cables : Part 47 Impulse test
10810 (Part 45) : 1984	Methods of test for cables : Part 45 High voltage test	10810 (Part 48) : 1984	Methods of test for cables : Part 48 Dielectric power factor test

ANNEX B

(Clause 6.6)

CALCULATION OF SHORT CIRCUIT CURRENT

B-1 The short circuit current is calculated by using the following formula :

I² = (K² S² / T) logₑ (Q₁+B / Q₀+B)

where

- I = Short circuit current, Amps (rms over duration),
- T = Duration of short circuit, second
- K = Constant for the material of the conductor
- S = Area of cross section of conductor,
- Q₁ = final temperature of conductor,
- Q₀ = Initial temperature of conductor, and
- B = Reciprocal of the temperature coefficient of resistance of the conductor (per°C at 20°C)

B-2 The constants of some metals are given in Table 3, in which

K = (Q₀ (B+20) / Pₛ₀)

- where
- Q₀ = Volume specific heat of the conductor at 20°C (J/°C), and
 - Pₛ₀ = Resistivity of conductor material at 20°C (ohm-cm)

Table 3 Constants for short Circuit Calculations

(Clause B-2)

Sl No.	Material	K	B	Q₀	Pₛ₀
(1)	(2)	(3)	(4)	(5)	(6)
1	Copper	226	234.5	3.45 × 10 ⁻⁸	17.241 × 10 ⁻⁶
2	Alumininm	148	228	2.5 × 10 ⁻⁸	28.26 × 10 ⁻⁶
3	Lead	42	230	1.45 × 10 ⁻⁸	214 × 10 ⁻⁶
4	Steel	78	202	3.8 × 10 ⁻⁸	138 × 10 ⁻⁶

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference:

Doc : No. ET 09 (2368)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices :

	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	{ 331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	{ 37 84 99, 37 85 61, 37 86 26, 37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	{ 53 38 43, 53 16 40, 53 23 84
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	{ 235 02 16, 235 04 42, 235 15 19, 235 23 15
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	{ 632 92 95, 632 78 58, 632 78 91, 632 78 92
Branches : AHMADABAD, BANGALORE, BHOPAL, BHUBANESHWAR, COIMBATORE, FARIDABAD, GHAZIABAD, GUWAHATI, HYDERABAD, JAIPUR, KANPUR, LUCKNOW, PATNA, THIRUVANANTHAPURAM.	